



# Use of Dogs for \*Reliable\* Route Clearance - Research Findings



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13. SUPPLEMENTARY NOTES <b>This briefing is a compilation of ONR and funded research applying to the use of dogs for standoff detection of home-made explosives</b>					
14. ABSTRACT <b>This NATO Route Clearance Working Group briefing discusses recent and current research into the science underlying explosive detection canine performance on dismounted patrols in Afghanistan. It highlights the novel US Marine Corps Improvised Explosive Device Detection Dog (IDD) and research into (1) ineffective and effective training aids for homemade explosives detection, (2) physiological resilience and thermal management, (3) canine cognition and temperment and (4) environmental effects on odor plume movement.</b>					
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# USMC IED Detector Dog Experiment – One Approach

Problem set provided by LtGen Mattis:

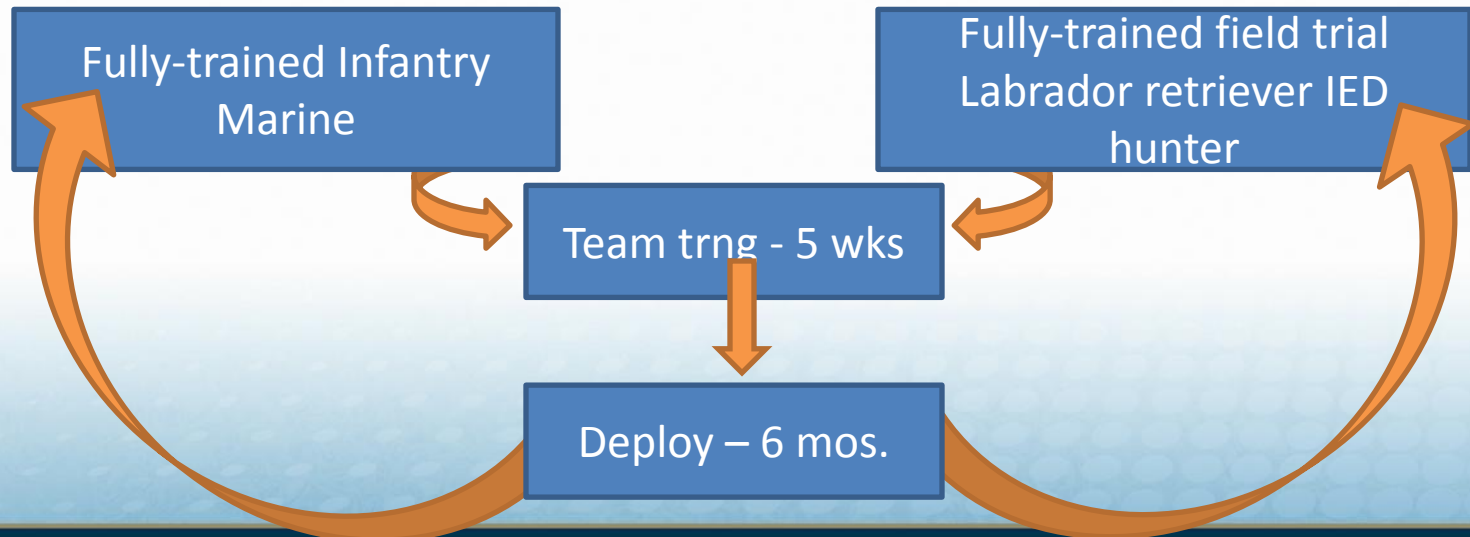
- Victim-operated IEDs reduce the freedom of movement necessary for effective dismounted patrols by squad-sized elements
- Marines on patrol are already carrying too much weight so the solution should minimize weight on the individual Marine
- The solution must have minimal impact on the battalion before and after deployment; NO long-term training will be supported
- Priorities are schedule-performance-cost





# Novel Model - Benefits

- Handler training reduced from 9 months to 5 weeks – no permanent assignment/kennels/structure
- “Recycle” allows opportunity for highly skilled trainers to identify and correct performance issues
- Dog can be adapted to changing mission/threat/environments
- Concentrates resources where they are needed







# Route Clearance

- Understand the IED threat and environment
- ~~Target IEDs to ensure RC patrols are in the right place at the right time~~
- Develop route clearance formations and techniques
- Integrate RC enablers in the CIED fight
- ~~Prepare for RC missions and reporting~~
- Maintain and recover RC equipment

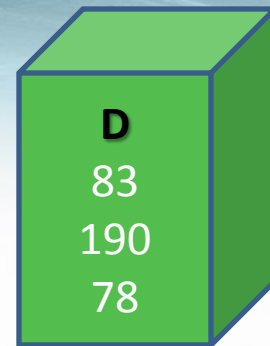
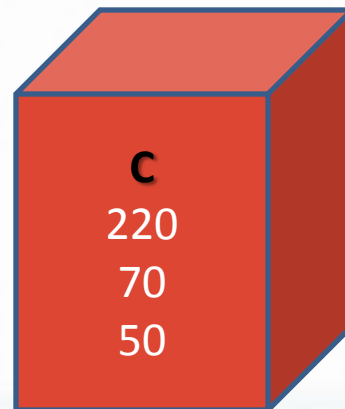
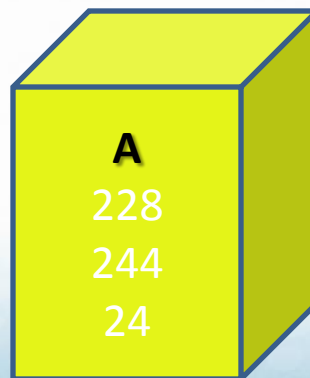
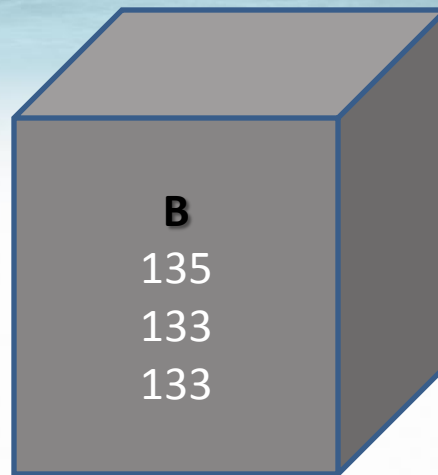
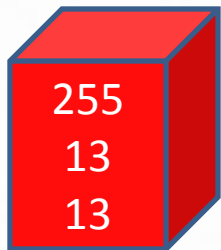
- Afghanistan Route Clearance Handbook, US Army, Sept 2011

**Dogs are a system of systems and are part of the larger system of systems used for successful route clearance**



# Understand the IED threat...

Which of these boxes is the same as this box?





# ...from the dog's perspective

Which of these odors  
is IDENTICAL to this odor?

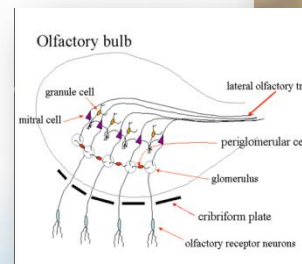
**Ammonium  
Nitrate (AN)**

**AN/  
Fuel Oil**

**AN/  
Powdered  
Aluminum**

**AN/  
Powdered  
Sugar**

**AN/  
Wood  
Pulp**



**Battelle**  
*The Business of Innovation*





# Imprinting v Training

- Imprinting – limited number of trials at minimal difficulty; likely will not be retained w/out reinforcement
- Training – ensuring the dog will detect and respond to a trained odor in a wide variety of operational environments, at heights and depths, despite novel and interesting odors, live animals, people, gunfire and other visual and auditory stimulus
- Certification – Assessment of basic work habits, odor recognition and reliability of trained response





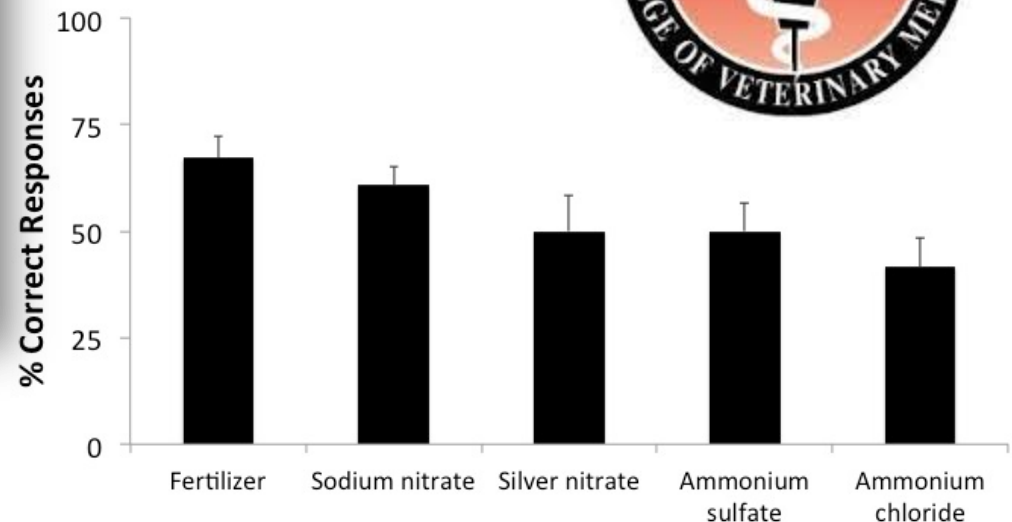


# Olfaction Research Results

Training with pure ammonium nitrate does **NOT** result in detection of chemicals containing ammonium or nitrate and another component\*



•Manuscript pending publication in Applied Animal Behaviour Science

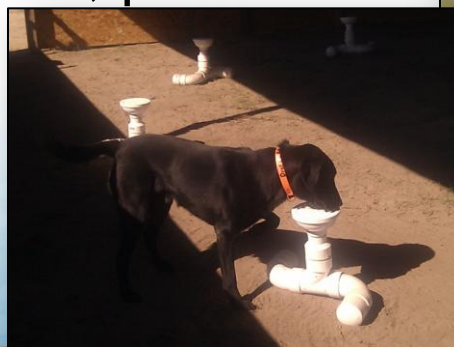




# Mixed HME LOEs

- Dogs trained to detect and respond to a specific substance are tested using a mixture of the target substance and a fuel such as would be found in an HME IED\*
- Results vary by type of fuel, individual dogs and other unknown factors
- Responses are not uniform, predictable  
OR RELIABLE

\* Manuscript submitted to Applied Animal Behaviour Science





# AN-based HME LOE

- 45 dogs certified for AN detection
- Imprinted and validated on AN+fuel A
- Tested 30-45 days after imprinting

	AN	AN+fuel A
Respond as trained	45	0
No interest	0	45





# PC Based HME LOE

- 17 dogs validated at 100% correct unassisted final response on potassium chlorate and no false responses on distracter odors
- Then tested with actual PC-based mixed HME

	PC+fuel A	PC+fuel B	PC+fuel C	PC+fuel D
Respond as trained	5	7	7	12
Interest but no response	5	4	2	2
No interest	7	5	8	3

# So that means.....



≠

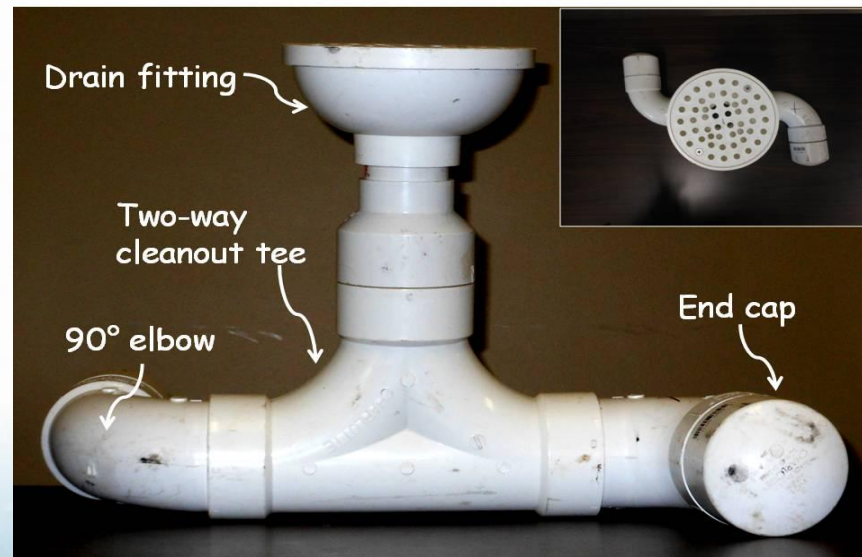


## Training the dog to detect carrots does NOT train him to find beef stew

Wilson, Donald A., and Richard J. Stevenson. "Learning to smell." *Baltimore: Johns Hopkins UP* (2006).

# But....

- Dogs imprinted and trained with separated components of mixed HME will detect and provide trained response to the actual HME



\* Provisional patent filed





# Important Research

- Individual dogs cognitively process odors differently
- The more odors the dog is trained on, the more quickly he learns new target odors
- Variety in training aids increases alerts to non-trained variants
- Dogs remembered trained odors at least 4 mos. without refresher training (in a laboratory environment)



Johnston, J. M. "Canine detection capabilities: Operational implications of recent R & D findings." *Institute for Biological Detection Systems, Auburn University* 1.7 (1999).



# More Considerations

- Dogs often aren't detecting the energetic materials; they are more likely detecting other chemicals in the headspace
  - Proven in commercial explosives; likely in HME\*
  - If you don't know what they are using to make the detection, you MUST train using every possible variation of the odor
    - Locally procured materials
    - Prill v ground
    - Pakistan has no EPA!

\*Harper, Ross J., José R. Almirall, and Kenneth G. Furton. "Identification of dominant odor chemicals emanating from explosives for use in developing optimal training aid combinations and mimics for canine detection." *Talanta* 67.2 (2005):



# Train for Success

- Train your dogs using multiple variations of locally-sourced HME components prepared and packaged similarly to those you are trying to find
- Train in the environments or similar environments to those you will be searching (simulated training environments are **inadequate**)
- Train for similar lengths of time
- Context matters to dogs\*



\* Gazit, Irit, Allen Goldblatt, and Joseph Terkel. "The role of context specificity in learning: the effects of training context on explosives detection in dogs." *Animal Cognition* 8.3 (2005): 143-150.





# Train for Your Game



[ctlctr.com](http://ctlctr.com)



# Physical Fitness

- Does your current conditioning program prepare your dogs for their expected activities?
  - The myth of the 20-minute dog\*
  - Fatigue = inattention
  - Hyperthermia = poor performance and injury



\*Garner, Kelly J., et al. "DUTY CYCLE OF THE DETECTOR DOG: A BASELINE Study."  
*Auburn, AL: Auburn University (2001).*

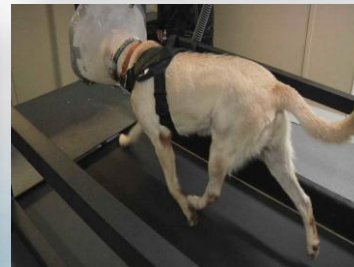






# Environmental Chamber

- Temperature controlled from -20 (+/- 10 degrees) to +120 (+/- 10 degrees)
- Observation Area
- Medical data gathering capabilities
- Treadmill
- VO<sub>2</sub> max measurements







# High-intensity Training

- USMC off-leash dogs cover 20-24 miles per day during deployment
- Progressively expose the dogs to deployment-intensity exercise
  - 5 weeks, 3X/week
  - Add an hour of exercise and an hour of rest each week
- Integrate odor and directional control to physical conditioning

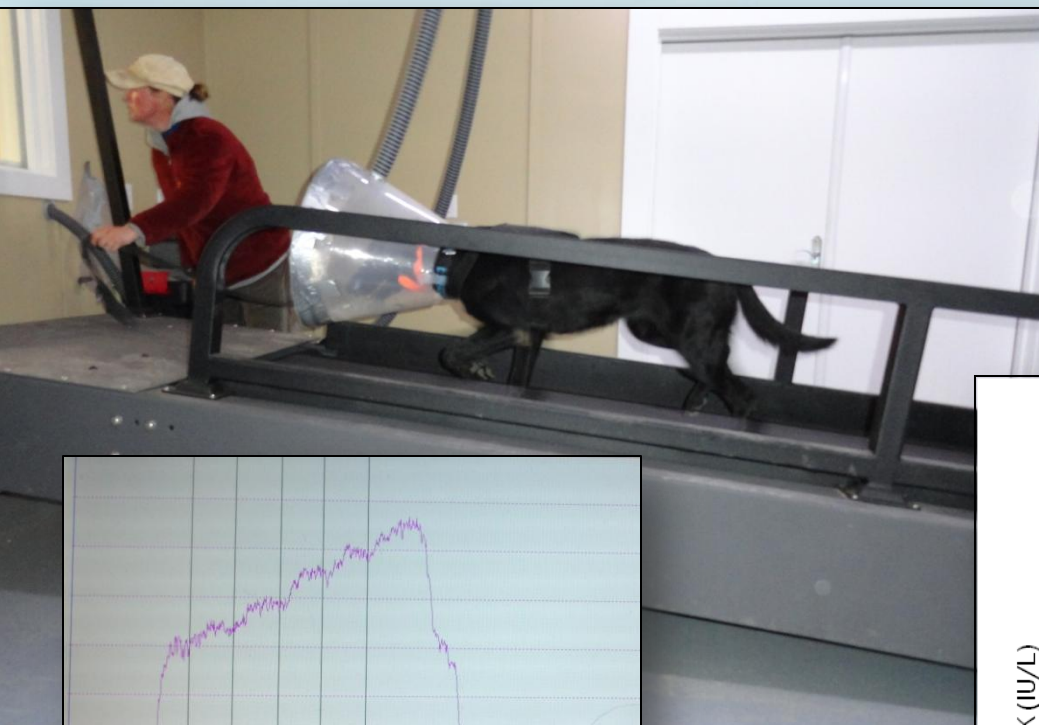




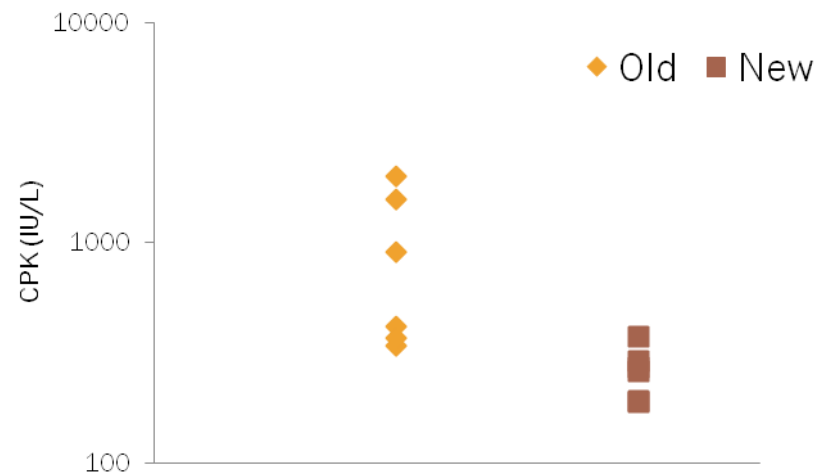
# Results...

VO<sub>2</sub>max increased by 10%

Test dogs were less fatigued and had less post-exercise muscle damage than control dogs



Post-exercise Serum CK Values





# And More....

- Conditioning improves static heat tolerance
  - No change in panting threshold for sedentary dogs; no hyperthermia after 1 hr
- Conditioning improves exercising heat tolerance
  - Chamber temperature 85F
  - 15 min, 6 mph on the treadmill
  - Tests ability to simultaneously support muscle work and heat dissipation
- Cooling vests
  - Ineffective under laboratory conditions





# Taking on the Cold

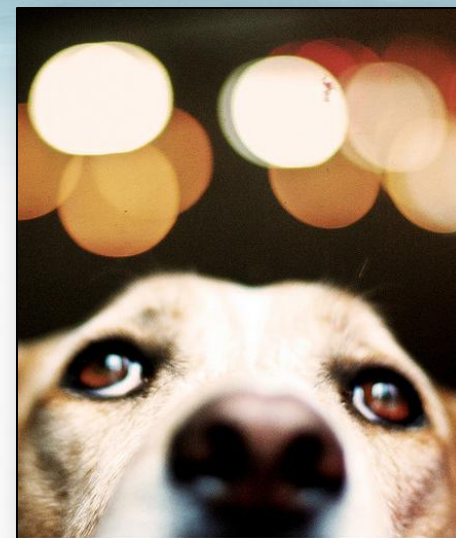
- Currently working with OKSU at SP Kennels, Two Rivers, AK
  - 2013 winner of the 1,000 mile Yukon Quest 11 Feb in record time!
    - First team to finish in under 9 days
    - After traveling 900 miles, completed the final 70 miles at 9 mph (14.5 km)
- Cold effects on dog physiology including “sensor”
- Cold effects on vapor pressure





# Cognition and Temperament

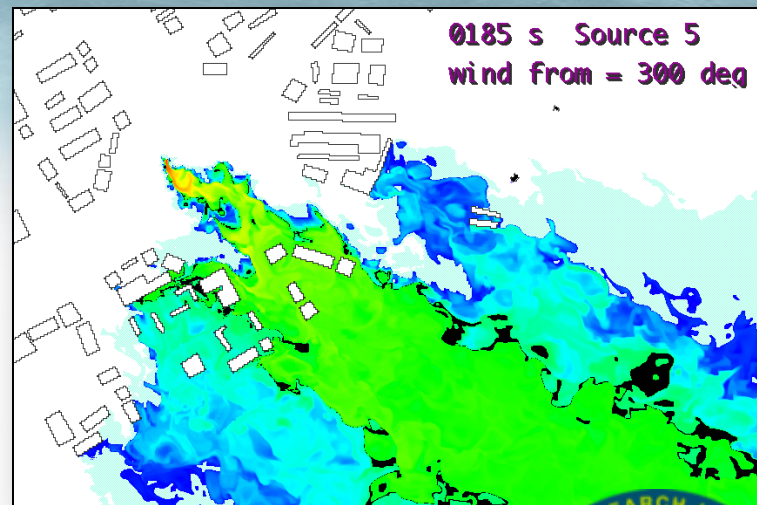
- What makes a “smart” dog?
  - Independence?
  - Spatial awareness?
  - Ability to learn?
  - Learning retention?
  - Problem solving?
  - Ability to change solutions when circumstances change?





# Environment

- Effects of:
  - Temperature
  - Humidity
  - Wind speed and direction
  - Transport through ground
  - Method of emplacement
  - Chemical changes over time







# Future Work

- Olfaction and cognition
  - standardized method to train dogs to categorize reliably?
- Physiology
  - Cold and altitude
  - Jungles
- Teaming with robotics and autonomous movement
  - Social behavior and cognition
- Outreach
  - DoD and DHS teaming
  - Int'l Canine S&T Conference (London 2012)



# Conclusions

- For now, dogs are the single sensor that can reliably provide standoff detection of explosives and explosive precursors
- In order to be effective, the dog has to be:
  - trained for the mission and threat,
  - able to work within the operating environment, and
  - in peak condition for the work he will perform
- If you want the dog to detect XXX you can't train with X
- We can optimize dog performance through research and application of research findings



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**“Run fast, bark loud”**